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Effects of Impact Versus Non-impact Cardiovascular Machines in Individuals between Age 50 and 80 Years

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Abstract

Older adults are at increased risk of injury when initiating exercise due to inactivity, functional limitation, illness, or fall risk. We studied a novel non-impact cardio unit in an effort to determine whether there were differences in physiologic, functional, and strength benefits compared to a treadmill (TM), while producing less stress on the knee and lessening the risk of fall and injury. Utilizing a prospective, randomized, non-blinded, cohort design, individuals aged 50–80 years were recruited and enrolled in a 16-week exercise program. Subjects were randomly allocated to either exercise on the Cybex arc trainer or on a TM. Participants exercised for 120 min per week. Resistance was adjusted to achieve a target RPE in each group. Functional, strength, and physiologic markers were analyzed through balance testing, ten – repetition max leg press, body composition analysis, and lipid panel results. Overall health-related quality of life was also measured. There was a significant improvement in triglyceride and very low density lipoprotein levels from baseline to exit within the arc trainer group. An equal and significant increase in strength capacity was observed in both the arc trainer and TM groups, as were feelings of increased energy, improved emotional well-being, and decreased fatigue. Leg strength increased, percentage of body fat decreased, and balance improved following use of either an arc trainer or a TM in a study population of 58 participants over a 16-week period. This study demonstrated that positive change occurs, physiologically and psychologically when an arc trainer or TM is utilized. Given the similar benefits seen in this study, use of a non-impact modality such as the arc trainer may be a better alternative in the older population.

Keywords Arc trainer · Treadmill · Triglycerides · Very Low Density Lipoprotein · Body Composition

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Introduction

As we age, normal attrition of physiological function becomes increasingly apparent when physical activity remains low. The benefits of exercise in the aging adult are well-documented including improved mental health, decreased fall risk, and enhanced cardiovascular and musculoskeletal fitness. Current guidelines recommend 150 min of moderate-intensity aerobic activity or 75 min of vigorous-intensity physical activity, in addition to muscle strengthening activity at least two days of the week (CDC 2019). Recent studies have demonstrated that the rate of aging is also variable among people in that environmental influences can modify its progression. Though genetic predispositions may increase susceptibility to certain diseases and conditions, strong cardiac power output, skeletal muscle function and metabolic function, including maximal oxygen uptake (VO2 max), have correlated with active healthy lifestyles (Boss and Seegmiller 1981). The purpose of this study is to examine whether there is a benefit in physiologic, functional and strength markers among adults aged 50–80 years old performing cardiovascular activity on the Cybex Arc brand trainer versus a standard treadmill, while maintaining a Rate of Perceived Exertion of Seven on a Modified Borg Scale.

The decline in physiological function examined with aging is similar to that which generally accompanies inactive, sedentary lifestyles (USDHHS 1996; Houghton et al. 2016; Xue 2011). Increased physical activity has been scientifically proven through dose-dependent analyses to reduce the risk of cardiovascular and metabolic disease through better management of blood pressure, cholesterol, and body mass. For example, physical activity regulates glucose and increases fatty acid oxidation in skeletal muscle, rather than in intramuscular and adipose tissue stores, thereby reducing the risk of type-2 diabetes mellitus and myocardial infarctions (CDC 2010). Aerobic exercise has been shown to positively impact changes in lipoprotein levels, with high-density lipoprotein cholesterol (HDL-C) being the most sensitive. Reducing serum cholesterol helps lower the risk of coronary heart disease and improve the prognosis of cardiovascular disease (Wang and Xu 2017). Neurological benefits of active lifestyles include improved cognitive function, balance and coordination, and reduced risk of falls. An increase in muscle mass and power has also been directly associated with improved mobility in older populations (Cheitlin 2003; McPhee et al. 2016).

With the exponential expansion of the fitness industry to promote physical activity among varying age groups, came the advancement of technology designed to target individuals expressing varying biomechanical limitations and accommodate perception of comfort. Certain motions can also impose stresses on joint structures in the body, such as the jarring forces experienced when running, which can alter one's inclination to exercise especially if injury has incurred or if the risk of such activity is elevated. Cardiovascular exercise modalities designed to displace kinetic energy and reduce compressive and shear stresses continue to be manufactured in order to meet the demands of such an evolving industry (Rogatzki et al. 2012).

Gait simulators were later designed to reproduce limb movements by replicating the gait patterns of treadmills while also eliminating the impact perceived to induce joint and skeletal injuries. The adaptive motion trainer (AMT), another non-impact cardio machine, was created in an effort to combine the movements simulated on an elliptical, treadmill, and stepper wherein the user of the equipment defines their own path of movement through the foot pedals. The arcuate (arc) cross trainer was designed to simulate an invariable arc path of motion in advance of the traditional elliptical cross trainer in which the footplate moves in an elliptical type pattern (Graves and Juris 2004). The arc trainer is a cross training device that claims to utilize the natural stepping motion of an individual to properly displace stress on the knee joints while recruiting one's glutes and hamstrings (Cybex 2012).

While studies exist comparing various cross trainer devices to the standard treadmill, much literature focuses on physical discomfort and biomarkers such as VO2 max rather than on the differences in strength, balance, body fat percentage, and perception of overall health especially in the older population. Our hypothesis is that a statistically significant difference in physiological, functional and strength markers can be found in a Cybex Arc brand trainer group as compared to those that utilize a treadmill. Through better understanding of the impacts of certain exercise modalities on the older population, we can better encourage such individuals into being more physically active while minimizing the risk and perception of injury and maximizing their physical capabilities.

Methods

Utilizing a prospective, randomized, non-blinded, cohort design, participants between the ages of 50 and 80 years were recruited from the community into a 16-week exercise program via advertisements and word-of-mouth across the central region of New Jersey between August 2015 and January 2017. Each participant was screened for age requirement (50 to 80 years) and medically cleared by their primary care physician. Participants were excluded if they had been actively exercising six weeks prior to the study start date, and if they had a history of significant lower extremity traumatic injury or symptomatic osteoarthritis that would prohibit use of the study equipment. In the case that the minimum required 39 out of 48 sessions compliance rate was not attained by week 16, participants were asked to continue in the study for no more than two additional weeks to accumulate the minimum target number.

Due to the nature of this study in its pilot phase, convenience sampling was used to select a sample population from the target population. There was random allocation to exercise on the Cybex arc trainer or a Cybex treadmill (Cybex International, Inc., Rosemont, IL). Randomization was achieved utilizing a random number generator for all participants. Though prescriptive for optimal results to patients with varying cardiovascular disease risk factors, the European Society of Cardiology recommends regular exercise training three or more times per week and at 30–45 min per session (Wang and Xu 2017). Participants in this study exercised for a total of 120 min per week divided into three 40-min sessions, with five minutes allotted for warm – up and cool – down periods.

The target Rate of Perceived Exertion (RPE) was seven of ten measured during each exercise session by the Modified Borg Scale, which is routinely used to monitor exercise intensity. Arc trainer subjects exercised at a constant step rate of 120 steps per minute (SPM), and resistance was adjusted to also achieve an RPE of seven. The treadmill subjects walked at 3.0 miles per hour (MPH) and the incline was adjusted to achieve an RPE of seven. Measure of health status, and functional, strength, and physiologic biomarkers were monitored throughout the course of the study at specific intervals and defined below. To account for aerobic adaptation to exercise, resistance on both machines was increased every four weeks to achieve and maintain an RPE of seven.

Physiological biomarkers included heart rate, body fat composition, high density lipids (HDL), and hemoglobin A1c (HbA1c). Body composition (body fat percentage) was analyzed using a dual-energy x-ray absorptiometry (DEXA) scan. DEXA scans provide an accurate measure of fat in the body, lean muscle mass, and bone mineral density (BMD) using a very low radiation dose. Body composition, body mass index, and blood work were collected at baseline and at week 16 completion. Heart rate was monitored during each exercise session. Bloodwork was collected in a fasted state and included a lipid panel, and HbA1c test to determine average blood sugar levels. Very low density lipoprotein was examined as a secondary marker since it contains more triglycerides, as carried through the bloodstream, than low density lipoprotein which contains more cholesterol.

Functional testing was performed using the BioSway machine to measure static balance. The BioSway emphasizes specific movement patterns, encourages proprioception and motor control and is ideal for vestibular training. Participants were asked to balance on a firm surface for 20 s standing in a natural stance with their eyes open, and then again with their eyes closed. They were then asked to repeat the same procedure on a three-inch thick foam surface. Each participant's sway index was then computed by the machine based on age and height standards. Sway was characterized by assigning a value of one to four; one equals minimal sway, four equals a fall. Using a validated formula, strength was assessed utilizing a standard leg press to extrapolate maximum weight at one repetition (1 RM) for study monitoring at ten repetitions (10 RM). The formula was incorporated to avoid potential injuries from using the equipment on the study population. Strength and balance testing were measured at baseline and then every four weeks until study completion.

The RAND 36-Item Short Form Health Survey (SF-36 Survey) was administered at baseline and at week 16 completion to assess any changes in the health-related quality of life of each study participant. The SF-36 Survey relied upon participants self-reporting and included the following eight measures to gage their perception of overall health: vitality, physical functioning, bodily pain, general health, physical role functioning, emotional role functioning, social role functioning, and mental health.

The SF-36 Survey was scored utilizing a two-step process. Pre-coded numeric values were first recoded in accordance with RANDs standardized scoring key, wherein a high score defined a more favorable state of health via a 0 to 100 range. Scores represented the percentage of total possible scores achieved. Scores within the same scale or health concept group were averaged together to generate the eight-scale scores. Missing data were not factored into the analysis (RAND Corporation).

Statistical Analysis

The main variables of interest that were collected during this study were body fat percentage (DEXA scan), strength measured through 10RM, hemoglobin A1c, and HDL. Secondary outcome measures included BMD and lean muscle mass. Data was tested for normality using the Anderson–Darling and Kolmogorov-Smirnov tests. Variables that failed normality were analyzed using non-parametric analyses via Wilcoxon Signed-Rank and Mann-Whitney tests. Variables that did not fail normality were analyzed using parametric statistical tests including paired and two-sample t-tests. Participant demographic information was summarized using descriptive statistics and compared to make sure there were no significant differences between groups. Change in body fat percentage, 10RM, HbA1c, and HDL were analyzed within group using paired t-tests and then compared between groups using two-sample t-tests.

The significance level for interpreting the *p* value was set at 0.05. All data was analyzed using Minitab statistical software, version 17, (Minitab, State College, PA, USA); and IBM SPSS statistics for Windows, version 26, (IBM Corp., Armonk, N.Y., USA).

Results

79 individuals were screened for eligibility and randomized into the study, of which 15 dropped out prior to study completion and six yielded insufficient data. Of the 58 participants analyzed, 47 (81%) were female and age ranged between 50 years to 77 years with a mean of 60.67 and standard deviation of 6.82.

Cholesterol, LDL, and HDL levels in participants from both the arc trainer and treadmill groups trended towards improvement but did not reach statistical significance. Cholesterol and LDL decreased by 5.52 mg/dL and 2.2 mg/dL in the arc trainer group, respectfully, while HDL increased by 1.4 mg/dL. In the treadmill group, cholesterol and LDL decreased similarly by 4.42 mg/dL and 4.41 mg/dL, while HDL increased by 0.91 mg/dL. Triglycerides and VLDL values decreased significantly in the arc trainer group with *p* values of 0.011 and 0.012, respectively. Triglycerides decreased by 18 mg/dL, while VLDL decreased by 3 mg/dL. The treadmill group also demonstrated improvement in triglyceride and VLDL values with decreases of 9 mg/dL and 2.5 mg/dL, respectfully, but did not reach statistical significance Figs. 1 and 2. Hemoglobin A1c values showed no difference in either group from baseline to exit data collection points. Table 1.

Strength capacity via the ten – repetition maximum leg press increased equally and significantly by 55 RMs in both the arc trainer and treadmill groups, *p* values of 0.001 and 0.001, respectively. Table 2. Though lean muscle mass in the arc trainer and treadmill groups both decreased from baseline to week 16 with changes of 28 and 455 g, respectfully, only results from the treadmill group were statistically significant (p value of 0.031). Slight improvement in body fat percentage through DEXA scan analysis was also evident in participants from both groups demonstrating a decrease of 0.8 and 0.6% in the arc trainer and treadmill groups, respectively. The difference observed in BMD from the

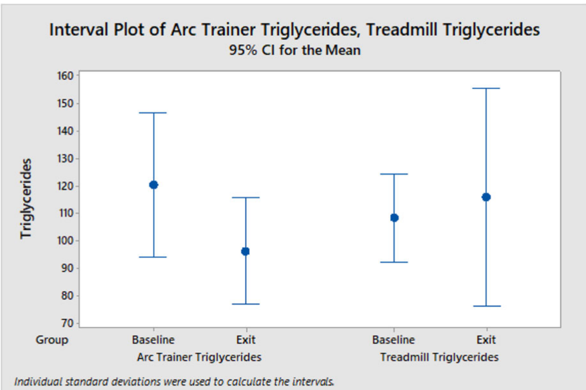

Fig. 1 Interval plot demonstrating the effect of arc trainer and treadmill use on triglycerides (grams)

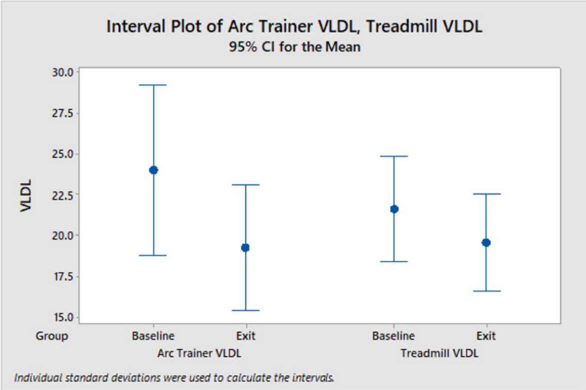

Fig. 2 Interval plot demonstrating the effect of arc trainer and treadmill use on very low density lipoprotein (grams)

treadmill group was small, with an increase of 0.002 g/cm^2. BMD in the arc trainer group was negligible. BMD results from both groups were statistically insignificant. Table 3. Balance scores, quantified by the time-based pass-fail Sway Index, yielded varying results from each test group. Participants from both groups seemed to perform much better on a foam surface with their eyes closed by study completion, with those in the treadmill group reaching statistical significance (p value = 0.021). Table 4.

The average RPE for each study participant within each study group was calculated per session. The average RPEs per group for the duration of the study period were then compared. Scores obtained from warm up and cool down periods were not included in the analysis. There was no significant difference between the RPEs collected from the arc trainer (5.45 ± 0.85, N = 24) or treadmill (5.24 ± 1.21, N = 33) groups, and both groups averaged 5.35 out of 10 on the Modified Borg Scale over the 16-week study period. In other words, when asked to rate the intensity of breathlessness utilizing a scale of zero (*Nothing at All*) to ten (*Maximal*), a value of "five" indicated participants were experiencing having a "hard" ability to breathe while exercising.

The SF-36 Survey measured the following eight health concepts: physical functioning, bodily pain, role limitations due to physical health conditions, role limitations due to personal or emotional conditions, emotional well-being, social functioning, energy/fatigue, and general health perceptions. Participants completed the survey at baseline and at the completion of the study. Significant improvement in emotional well-being and feelings of increased energy and decreased fatigue within the 16-week study period was demonstrated in both the arc trainer (p value = 0.046, p value = 0.007) and treadmill groups (p value = 0.009, p value = 0.004), respectively. Perception of general health within the treadmill group also showed statistically significant difference demonstrating an increase score of 10 points on the scale (p value = 0.05). There was no statistical difference between the arc trainer and treadmill groups for each of the eight health concepts tabulated. Table 5.

Discussion

The intent of this pilot study was to examine the feasibility of testing for physiologic and psychological differences between use of an arcuate trainer and treadmill for

Table 1 Descriptive statistics of bloodwork distribution between the arc trainer and treadmill groups from baseline to 16-weeks

Variable		**Arc Trainer** $N = 25$	**Treadmill** N = 33	***p* value**
Cholesterol (mg/dL)	Baseline	193.88 ± 37.71	195.27 ± 38.02	
	16 Weeks	188.36 ± 31.1	190.85 ± 43.07	
	Difference[a]	−5.52 ± 24.04	−4.42 ± 18.46	0.851[b]
	p value	0.262[c]	0.178[c]	
Triglycerides (mg/dL)	Baseline	103 (50–296)	102 (42–225)	
	16 Weeks	79 (52–249)	100 (35–695)	
	Difference[a]	−18 (−114–36)	−9 (−85–540)	0.2786[e]
	p value	0.011[d]	0.178[d]	
LDL (mg/dL)	Baseline	109.24 ± 31.34	107.97 ± 36.73	
	16 Weeks	107.04 ± 29.49	103.28 ± 41.98	
	Difference[a]	−2.2 ± 19.77	−4.41 ± 17.53	0.663[b]
	p value	0.583[c]	0.165[c]	
VLDL (mg/dL)	Baseline	21 (10–59)	20 (8–45)	
	16 Weeks	16 (10–50)	19 (7–39)	
	Difference[a]	−3 (−23–7)	−2.5 (−17–17)	0.3889[e]
	p value	0.012[d]	0.098[d]	
HDL (mg/dL)	Baseline	60.64 ± 14.22	65.67 ± 13.58	
	16 Weeks	62.04 ± 14.38	66.58 ± 15.74	
	Difference[a]	1.4 ± 7.77	0.91 ± 6.9	0.804[b]
	p value	0.376[c]	0.455[c]	
Hemoglobin A1c (%)	Baseline	5.6 (5–5.9)	5.6 (5–7.3)	
	16 Weeks	5.6 (5.3–6.1)	5.7 (5–7)	
	Difference[a]	0 (−0.3–0.4)	0 (−0.3–0.4)	0.6161[e]
	p value	0.881[d]	0.459[d]	

Note

N = Total sample size

Mean ± Standard Deviation (SD) or Median (Min – Max)

mg/dL = milligrams per deciliter

Hemoglobin A1c % = percentage of glycated hemoglobin in the blood

[a] Paired Difference

[b] Calculated using 2-sample t-test

[c] Calculated using paired t-test[d] Calculated using Wilcoxon signed rank test[e] Calculated using Mann Whitney

further consideration in a larger study to better gage the effectiveness of each device in the older population. Although the small sample size ineffectually detected differences between the intervention groups, we were however able to demonstrate statistically significant improvements while using both machines. This finding is important for the age group studied in that use of a non-impact device, such as the arc trainer or other cross-trainer modality, may be a safer way to reap the same benefits of cardiovascular

Table 2 Median numbers of the ten-repetition maximum leg press between the arc trainer and treadmill groups from baseline to 16-weeks

Strength Indicator		Arc Trainer N = 25	Treadmill N = 33	*p* value
10 RM	Baseline	110 (50–265)	105 (70–185)	
	16 Weeks	170 (80–425)	160 (105–255)	
	Difference[a]	55 (5–200)	55 (10–100)	0.6526[c]
	p value	<0.001[b]	<0.001[b]	

Note

N = Total sample size

Median (Min – Max)

10 RM = Ten repetition maximum

[a] Paired Difference

[b] Calculated using Wilcoxon Signed Rank[c] Calculated using Mann Whitney

exercise from that of a higher impact machine such as the treadmill which may place the user at increased risk of falls. Additionally, participants in the arc trainer group appeared to maintain more lean muscle mass compared to those in the treadmill group.

Table 3 Means and standard deviations of body fat percentage determined by DEXA Scan between the arc trainer and treadmill groups

Body Composition Indicator		Arc Trainer N = 24	Treadmill N = 33	*p* value
% Body Fat	Baseline	0.3915 ± 0.0827	0.4077 ± 0.0689	
	16 Weeks	0.3829 ± 0.0847	0.4013 ± 0.0649	
	Difference[a]	−0.00854 ± 0.01979	−0.00636 ± 0.01417	0.648[c]
	p value	0.046[b]	0.015[b]	
Lean Mass (g)	Baseline	43,516 ± 10,337	39,504 ± 5513	
	16 Weeks	43,489 ± 10,048	39,049 ± 5943	
	Difference[a]	−28 ± 1475	−455 ± 1160	0.245[c]
	p value	0.928[b]	0.031[b]	
Bone Mineral Density (g/cm^2)	Baseline	1.232 ± 0.1247	1.1411 ± 0.1236	
	16 Weeks	1.2325 ± 0.1190	1.1432 ± 0.1268	
	Difference[a]	0.00054 ± 0.02326	0.00206 ± 0.01632	0.785[c]
	p value	0.910[b]	0.473[b]	

Note

N = Total sample size

Mean ± Standard Deviation (SD)

DEXA = Dual-energy X-ray absorptiometry

[a] Paired Difference

[b] Calculated using paired t-test

[c] Calculated using 2-sample t-test

Table 4 Means and standard deviations of balance scores between the arc trainer and treadmill groups from baseline to 16-weeks

BioSway Sensory Conditions	Baseline $N = 24$ Mean (SD)	16 Weeks N = 24 Mean (SD)	Paired Difference	*p* value*
Arc Trainer				
EO Firm Surface SI	0.4871 (0.1786)	0.5604 (0.1506)	0.0733 (0.22)	0.116
EC Firm Surface SI	0.7342 (0.2493)	0.7908 (0.2616)	0.0567 (0.2482)	0.275
EO Foam Surface SI	0.8517 (0.2355)	0.785 (0.1642)	−0.0667 (0.2068)	0.128
EC Foam Surface SI	2.422 (0.555)	2.298 (0.564)	−0.1242 (0.4261)	0.167
Treadmill				
EO Firm Surface SI	0.5817 (0.2203)	0.5358 (0.1414)	−0.0458 (0.2465)	0.372
EC Firm Surface SI	0.7896 (0.2212)	0.7292 (0.181)	−0.0604 (0.2253)	0.202
EO Foam Surface SI	0.8271 (0.2033)	0.8342 (0.189)	0.0071 (0.1625)	0.833
EC Foam Surface SI	2.6833 (0.4531)	2.422 (0.767)	−0.262 (0.518)	0.021

Note

N = Total sample size

SD = Standard Deviation

EO = Eyes Open

EC = Eyes Closed

SI = Sway Index

**P* values calculated with paired t-test

Though not statistically significant, bone mineral content seemed to be maintained in the arc trainer group which, through use of that modality, consisted of more weight bearing exercise. The length of time the study was conducted may not have been beneficial to demonstrate enough change in bone mineral density. This is worth further exploration considering a study recently published on older obese adults that showed combining aerobic and resistance exercise protected against loss of BMD that can occur during weight loss efforts (Armamento-Villareal et al. 2019).

Although the findings showed that use of either modality yielded similar benefits, without use of a control arm, results may have been due to the increase in cardiovascular activity alone. Stratification of data by sex and distribution of age from a larger sample population may have also provided more clinically meaningful insight into the physiological and psychological processes that occur within this population.

Worth additional exploration is the potential reduction in an atherogenic lipid profile with the extended use of an arc trainer or other gait simulator. While the RPE was relatively consistent averaging 5.35 between participants from both groups, triglyceride and VLDL values within the arc trainer group decreased significantly in this study. Following attempts to determine the optimal prescription for improving cholesterol levels in patients, several studies have demonstrated that the frequency of exercise over duration at moderate intensity versus high intensity serve as important indicators of change (Mann et al. 2014; Kim et al. 2001). Exercise volume in this study may not have been enough to cause significant changes in lipids since it didn't meet a threshold to induce weight loss.

Table 5 Median numbers from results following the 36-item health survey distributed between the arc trainer and treadmill groups from baseline to 16-weeks

8 – Scale Health Concepts	Baseline		16 Weeks		*p*-Value*	
	Arc *N* = 32	TM *N* = 31	Arc *N* = 43	TM N = 25	Arc	TM
Physical functioning	95 (25–100)	95 (60–100)	90 (75–100)	95 (80–100)	0.251	0.002
Role limitations due to physical health	100 (25–100)	100 (0–100)	100 (50–100)	100 (0–100)	>0.999	0.584
Role limitations due to emotional problems	100 (0–100)	100 (66.7–100)	100 (33.3–100)	100 (33.3–100)	0.593	>0.999
Energy/fatigue	70 (45–90)	70 (10–100)	75 (45–100)	80 (40–100)	0.007	0.004
Emotional well-being	86 (60–96)	84 (52–100)	88 (68–100)	88 (72–100)	0.046	0.009
Social functioning	100 (75–100)	100 (37.5–100)	100 (87.5–100)	100 (75–100)	0.402	0.151
Pain	90 (45–100)	90 (57.5–100)	90 (32.5–100)	90 (57.5–100)	0.701	0.158
General health	77.5 (25–100)	80 (40–100)	75 (55–100)	90 (60–100)	0.067	0.05

Note

Arc = Arc Trainer (Group A)

TM = Treadmill (Group B)

N = Total sample size

Median (Min – Max)

* Calculated using Wilcoxon Signed Rank

The RPE averaged in this study may have also been the reason the HbA1c values were unaffected. Diet was not controlled for and the exercise intensity may have been performed in a range and at a duration that was not conducive to affect change. While studies have demonstrated varied results regarding the impact of exercise intensity on insulin resistance in patients with type 2 diabetes, exercise at mild to moderate intensity has been recommended as optimal for reduction in HbA1c long-term (Albright et al. 2010; Liu et al. 2019; Pai et al. 2012).

Given the potential impact to lower-limb joints utilizing non-impact cardio machines, further studies should be directed at assessing the amount of force placed on the hips and knees, more specifically the patellofemoral joint, during aerobic exercise while on the treadmill versus a cross-training device, including the arc trainer. Though not an objective of this study, limited independent quantitative analyses exist that examine directly the anatomical consequences of movement utilizing such equipment in comparison to the standard treadmill. Lu et al. (2007) examined joint loading in the lower extremities during elliptical exercise versus walking and found that the mobility of the pedal system may be a key indicator for potentially harmful loading at the knee (Lu et al. 2007). Increased loading on the quadriceps was also thought to in turn lead to premature fatigue of the engaged muscles thus negatively impacting the general effects of fitness training (Lu et al. 2007; Green et al. 2004). Recent research by the University of Wisconsin – La Crosse Department of Physical Therapy demonstrated that the use of the arc trainer in comparison to the elliptical cross trainer may decrease patellofemoral joint stress and the risk of patellofemoral pain syndrome (PFPS), or anterior knee pain, given the invariable path of motion compared to that of other non-impact cardio machines (University of Wisconsin 2012). Comparing physiologic responses and kinematic data obtained from measuring joint loading and reaction forces following artificial and natural movement will more objectively optimize results and avoid injuries. Utilizing the arc trainer for musculoskeletal conditioning in the older population may also be considered given the stability of the device and mechanism of action. By providing a stronger element of control by the user, the arc trainer may serve as a more secure option for individuals with gait and balance disorders to help prevent potential falls that might occur on a treadmill.

Conclusion

Leg strength increased, body fat percentage decreased, and balance improved following use of either an arc trainer or a treadmill for a period of 16 weeks (120 min/week) in a study population of 58 participants. Cholesterol, HDL, and LDL showed improvement when utilizing an arc trainer or treadmill, but a larger number of participants would be needed to demonstrate statistically significant comparisons in other physiological parameters. Continued use of either an arc trainer or treadmill over time also seemed to have a positive impact on one's emotional well-being, benefit physical functioning, and improve perceived levels of energy. Though statistical limitations exist, this study demonstrates descriptively that positive change does occur on a physiological and emotional level when the arc trainer or treadmill is incorporated into one's fitness regimen. Non-impact exercise may therefore provide the same benefits as impact exercise in a more conducive manner in the older population.

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Compliance with Ethical Standards

We know of no conflicts of interest associated with this manuscript, and there was no financial support for this research that could have influenced its outcome. Results of the study are presented clearly, honestly, and without fabrication, falsification, or inappropriate data manipulation. Research for this study was approved by the Atlantic Health System Institutional Review Board and written informed consent was obtained from each participant accordingly.

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